Vis3D 1.0

The 3D visualization tool

User's Guide

Written by Andrew Mercer

Updated by Michael Richards

Last update September 3rd, 2012

Table of Contents

Acknowledgements....2
Introduction....3
Scope....3
Functionality Summary....3
Running Vis3D....4
The Vis3D interface....5
The 3D Average window....5
The 3D Surface window....6
The 3D Maximum window....7
The 2D Slicer window....8
Other interface info....8
The Vis3D menu commands....9
File Menu....9
3D Image....9
Extras....10
Making Animations....10
Overview....10
Creating an Animation with Ulead....10
Creating an Animation with iMovie....11
Control Commands....12
3D Animation Commands....12
About the STEP Option....13
Sample animation scripts....13
Miscellaneous Notes....14

Acknowledgements

The code for Vis3D is primarily based on code from Acciss. Thanks go out to Albert Cross, Mohamad Akl, Steven Beyea, Changho Choi, David Goodyear, Bryce MacMillan, David Matheson, Pablo Prado, Pavol Szomolanyi, James Rioux, Igor Mastikhin, Ben Newling, Adam Richard, Ning Ma, and Bruce Balcom who all worked on Acciss in some way over the years and made it such a good starting point for this program.

The current version of Vis3D is 1.0, and was written by Andrew Mercer in the spring of 2012.

Introduction

Scope

Vis3D is designed to help visualize the internal structure of 3D data sets, view the flow of data in a time series, and create images and animations suitable for publication. It is not designed for quantitative analysis, but for qualitative analysis.

Functionality Summary

Vis3D is outfitted to provide many ways to view 3D data sets. This program can currently do the following:

- Read-in 3D .dat files created by Acciss.
- Display 3D data in three ways:
    - Average Intensity Projection -As the average of the data along a ray to the eye.
    - Maximum Intensity Projection -As the maximum of the data along a ray to the eye.
    - As a light shaded, surface – only object.
- Extract and display arbitrary 2D image slices from the 3D dataset
- All images are auto interpolated to a size of 512x512.
- Slice through the light shaded object, and reveal the internal structure of the object.
- Save a series of images as .GIF or .TIFF files that can then be turned into an animation with a separate utility program.

Running Vis3D

Vis3D was developed under EXELIS's IDL 7.1 Programming Environment. In order to run Vis3D you will need to be running Windows, Mac (OS X) or UNIX operating systems, and have either the IDL programming environment(version 7.1 or above) or the IDL Virtual Machine.

How to run Vis3D with the programming environment:

1. Start IDL first. If you do not have IDL jump to "Running Vis3D without the programming environment."
2. To run Vis3D, simply type "Vis3D" at the IDL command line.

Running Vis3D without the programming environment:

1. You will need to have the IDL Virtual Machine and the Vis3D.sav file in order to do this.
    a. The IDL virtual machine is installed when IDL is installed, but you do not need a license to run the virtual machine. It is a pain to install the entire thing, but at the moment there is no choice. IDL can be obtained from the current CS co-op student.
    b. The Vis3D.sav file should be found in a UNB MRI Programs folder. The program can also be obtained from the current CS co-op student.

2. Run the IDL virtual machine as you would any other program and it will bring up a dialog box asking to select a file. Select the Vis3D.sav and click open.

The Vis3D Interface

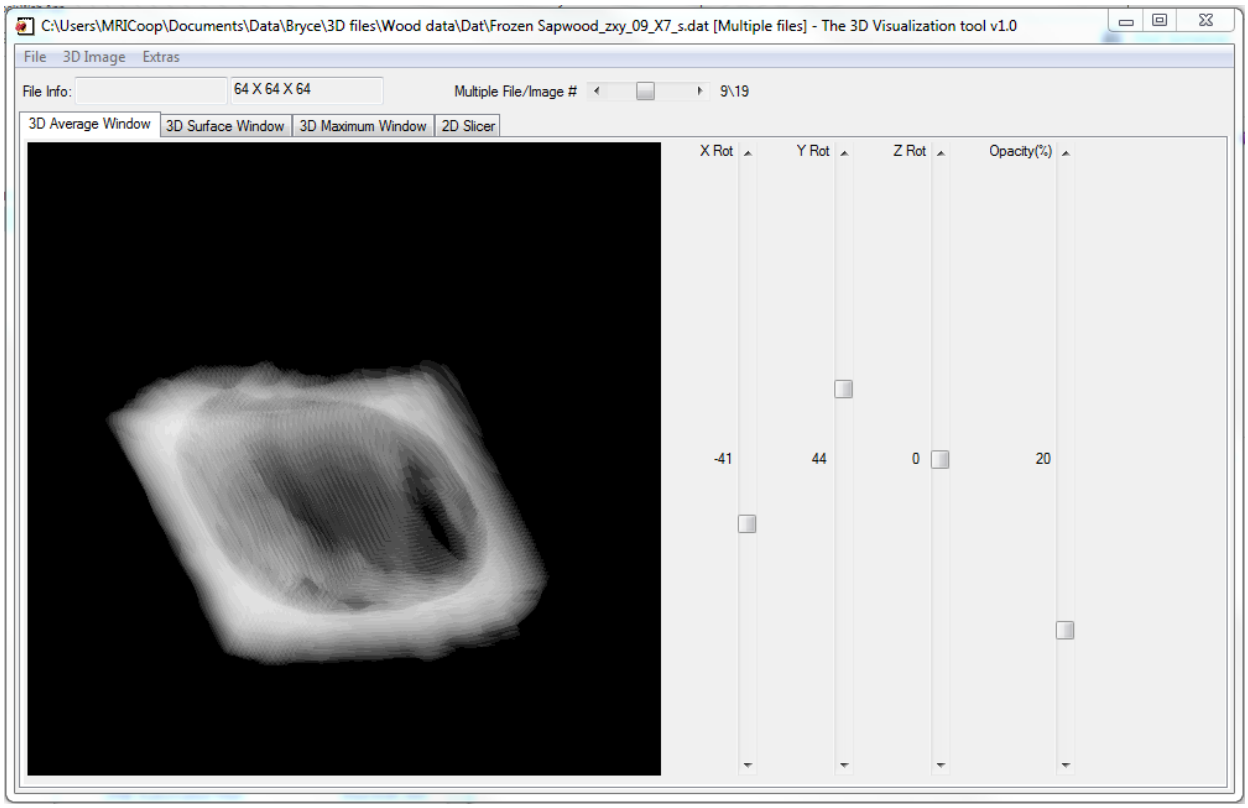
This section describes the functionality of each of Vis3D's four main graphics windows. The user can switch between these windows by clicking the tabs at the top of the screen.

The Average Intensity Projection Window

This tab calculates the average intensity of all points from the front of a view to the back, and displays a single 2D representation of the 3D object. Keep in mind this dataset will deliver an image from the perspective of signal density rather than individual signal detail. Things will appear smoother than in a point to point dataset.

This is a common way to display 3D image data as described in Volume Rendering by Drebin, Carpenter, and Hanrahan (Computer Graphics, volume 22, number 4, 1988). Multiple lines (or rays) are drawn from the far side of the image straight towards the users screen. The average intensity along those lines is what is displayed on the screen.

In order to get an understandable image the opacity and the orientation of the image must be adjusted. The default is for the image to be 100% opaque meaning that the image is solid. **The sweet spot for most images is around 20%.** At 20% the internal structure of the image should be visible, but depending in the user's data the opacity may need to be higher or lower. The opacity can be adjusted with the "Opacity (%)" slider. See page 8 for details on adjusting the orientation.



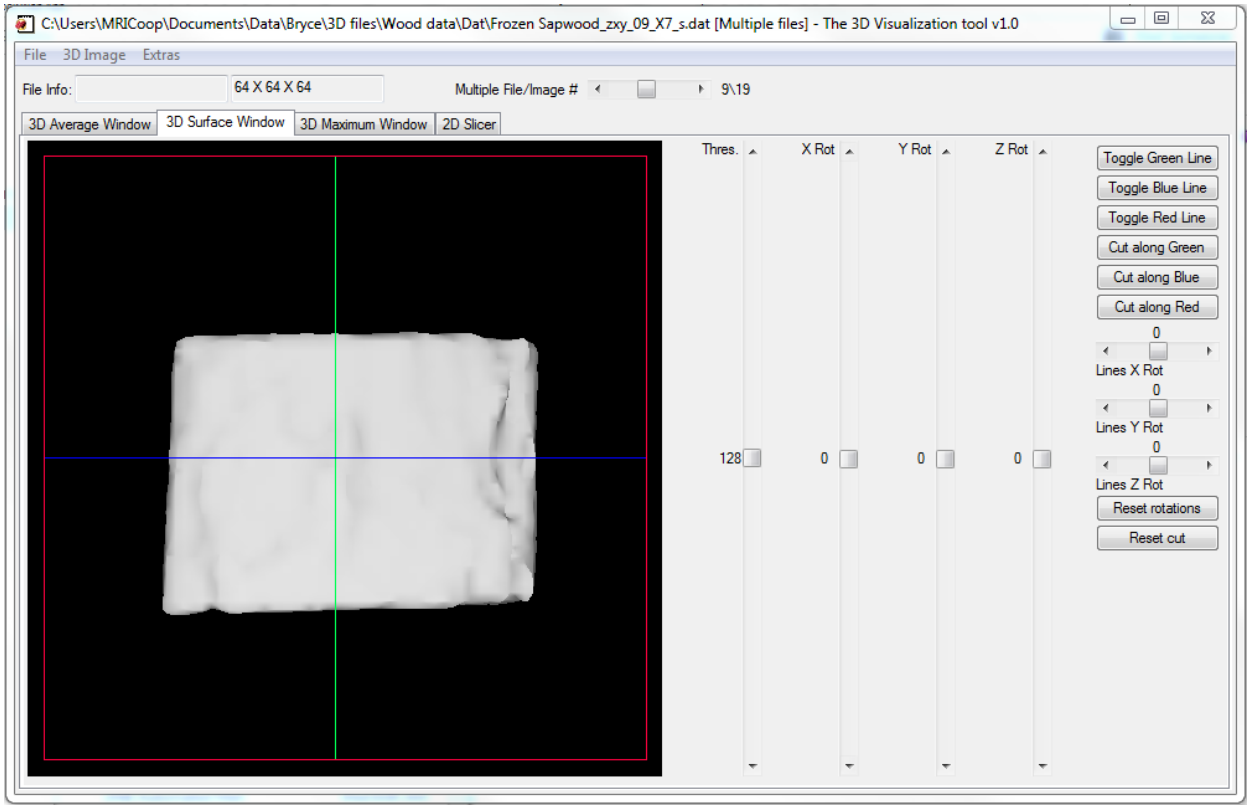
By clicking on the image the user can switch to the 2D Slicer along the horizontal click plane.

The 3D Surface Window

This tab only computes the outside shell of an image, and is also the tab which you can slice through an object to display a singular new surface created from the data within. Upon creating this surface, the piece to the right of the original image position will be cut off (or the top section if vertical). This results in an internal structure intensity image taking the place of the removed section.

- **NOTE:** This is also the tab which the animation function will take images from, utilizing the scripting function. Due to the programming of the slicing procedure, there are white spaces appearing within 2D data frames over time. This issue is ongoing and no solution has been identified yet but it is believed to be due to deletions made on the slice plane during cutting.

This window displays one of three surfaces: The last, the first or the current image in a defined series that has been loaded. The first or last image should be the fully visible object because the internal structure is better represented when the surface of the image remains the same.



There are 15 buttons and sliders on this tab that control the 3D surface tab, and each one is explained here:

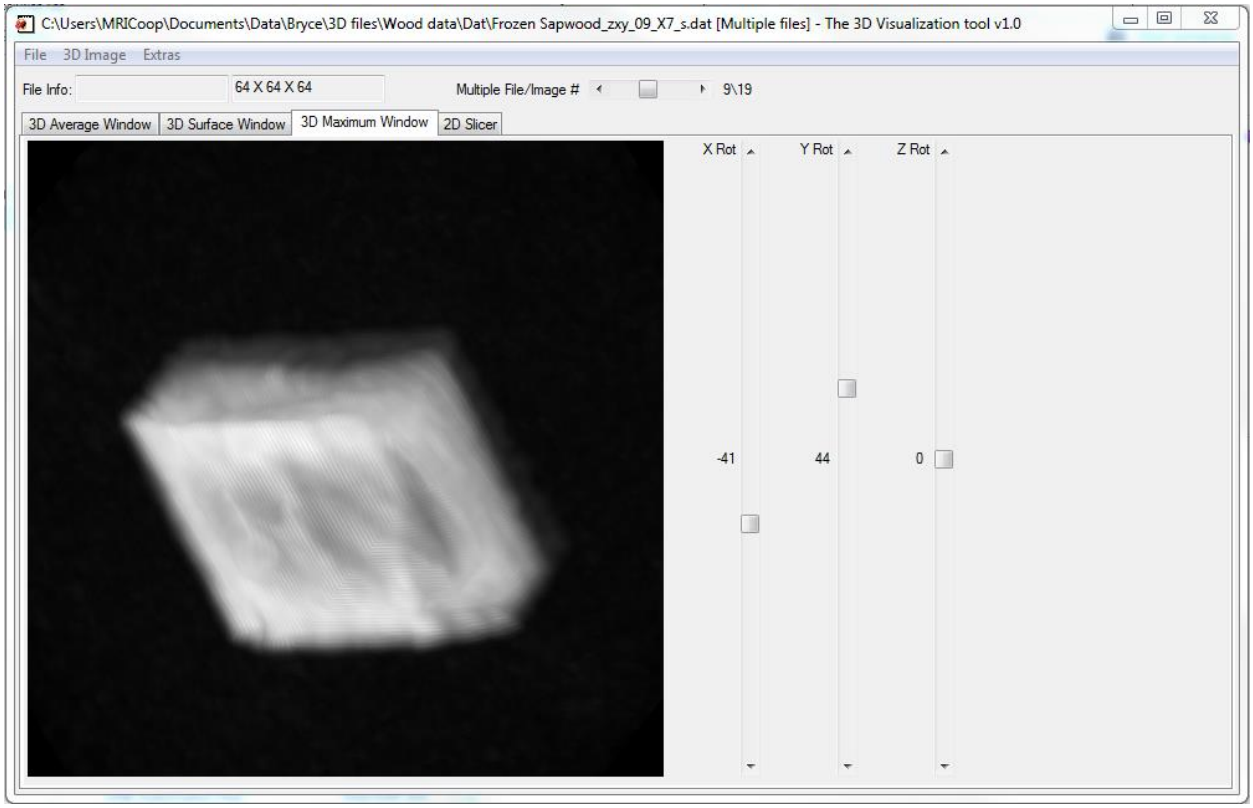
- The Thres slider alters the threshold. Pixels in the image below the threshold are not displayed. When the data is loaded all the values are changed to a scale from 0 to 255.
- XRot, YRot, and ZRot sliders rotate both the object and the lines around the corresponding axis. See page 8 for details on adjusting the orientation.
- The three toggle buttons make the corresponding lines disappear if the lines were visible and make the lines appear if they were invisible.
- The cut along buttons cut through the data along the corresponding line, remove all data to one side of that line, and display the 2D slice on the side of the object the cut was made.
- The Lines XRot, Lines YRot, and Lines ZRot sliders rotate just the lines around the corresponding axis.
- The Reset rotations button sets all the rotation sliders to 0.
- The Reset cut button places the cut data back into the object.

The mouse is also used to control the positions of the lines. By clicking on the displayed image the user can change the positions of the cutting lines.

The Maximum Intensity Projection Window

Given a particular viewing angle, the maximum intensity value present in a given X,Y coordinate pair THROUGH Z is displayed as a 2D image (Starting at the farthest depth and working towards the user, the highest intensity is chosen and displayed as a 2D image).

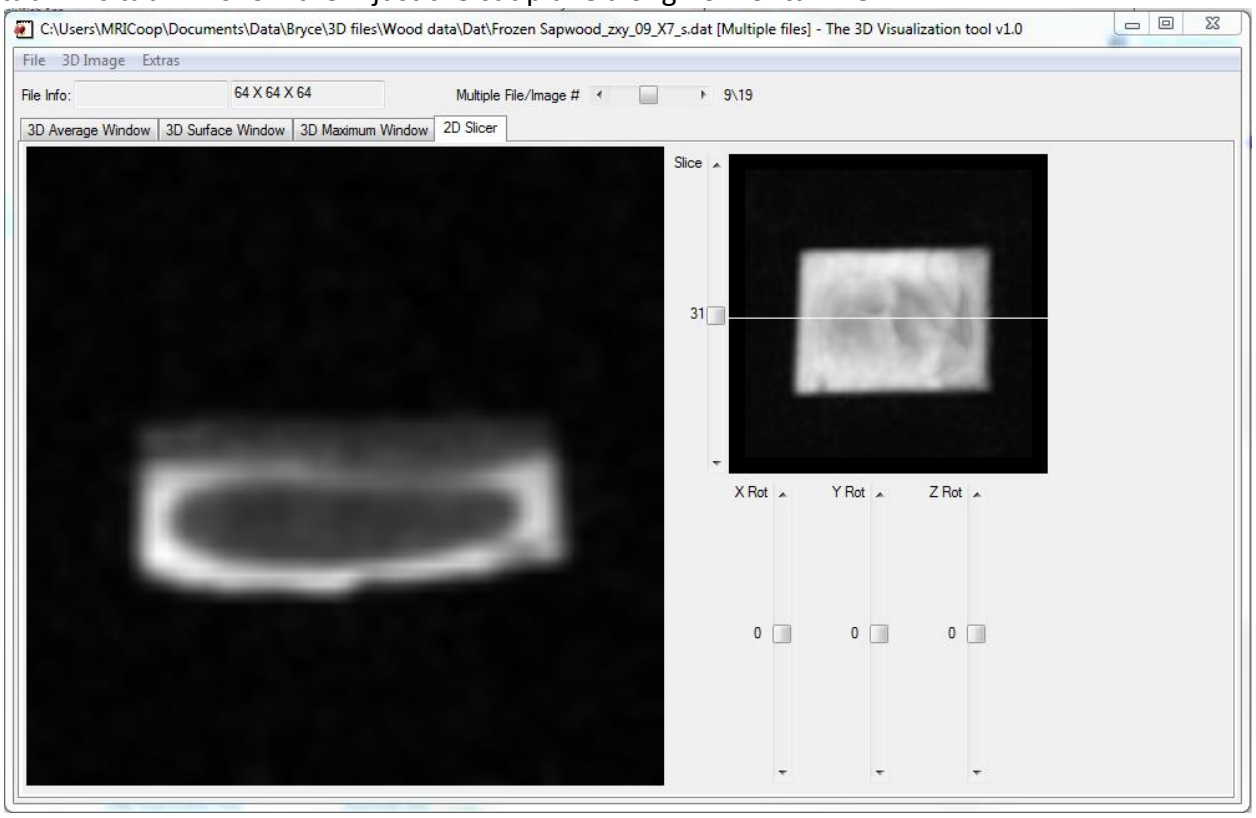
This is also a common way to display 3D image data as described in Volume Rendering by Drebin, Carpenter, and Hanrahan (Computer Graphics, volume 22, number 4, 1988). Multiple lines (or rays) are drawn from the far side of the image straight towards the users screen. The maximum intensity along those lines is what is displayed on the screen.



See page 8 for details on adjusting the orientation.

The 2D Slicer window

When the user clicks on the 3D average or max images they are taken to the 2D slicer tab. This tab will show them just the cut plane along horizontal line.



The cut plane can be changed with either the slider to the left of the mini 3D image or by clicking on the mini 3D image. The cut image can be in any orientation. In other words the cut does not need to be along the x-axis.

Other interface info

There is a slider near the top of the screen that says “Multiple File/Image #” beside it. This slider is used to switch between multiple 3D files. When these files are in the correct chronological order, and a slice is made in the 3D surface window the user can view the internal structure of the object changing over time.

Rotations are different between Vis3D and Acciss. In Acciss the axes moved with the rotations. In Vis3D the axes remain static. Using the xRot slider rotates the object around a horizontal line. Using the YRot slider rotates the object around a vertical line. Using the ZRot slider rotates the object around a line heading straight away from the center of the screen. There is one very important thing to remember when doing rotations in Vis3D: always go back the way you came. If you rotate 40 degrees around X and then 40 degrees around Y you should return to 0, 0, 0 by rotating YRot back to 0 and then xRot back to 0. If you return in the opposite way you will end up looking at the same spot, but the image will be twisted. If the image does get twisted use the “Reset rotations” button.

The Vis3D Menu Commands

File Menu

Open
Loads a 3D .dat byte file. If anything else is loaded the program will crash or not do anything useful.

Close File
Closes the currently loaded file.

Quit
Exits Vis3D.

Recent Files
This menu contains a list of the 5 files most recently opened in Vis3D.

3D Image

Zoom
Brings up a dialog that allows the user to increase or decrease the magnification of the currently displayed 3D dataset. The slider lets you choose a percentage for zooming from 1-100%. To get even more control over the zoom factor, enter a value other than 1 in the "Magnification" text box and push enter (or click Apply Magnification). This will make the actual zoom factor equal to the percentage shown on the slider times the value you entered.

Light Source(only effects 3D Surface window)
Opens a dialog that allows repositioning of the 3D light source. This makes the 3D object appear to be lit from a different direction.

Scaling(does not affect the 3D Surface tab when using Surface modes First and Last)
Allows changing between local and global scaling of 3D images. Local scaling means that the highest intensity point of that image appears white and the lowest black. Global scaling means that the highest intensity point of all the images appears white and the lowest black. All other values are interpolated between.

Resolution (only effects 3D Average and Maximum windows)
Allows for increased or decreased resolution (default low). This program will run faster with low resolution, but the quality of the image can be increased with high resolution.

Surface Mode (Only effects the 3D Surface window)
Allows for changes between the different surface modes: First, Last and Current.

Animate
Opens the 3D animator window. See "Making Animations" for more information.

Extras

Copy to New Window
Copies the currently displayed image to a new separate window.

Colour Table
Opens a dialog that allows the colour table to be changes. The default colour table is gray scale.

Making Animations

Overview

The Vis3D Animator module allows for easy creation of movies from 3D data. The movie is made up of a series of frames taken from the 3D Surface graphics window. All the animations are done with scripts, so any number of commands can be executed in sequence and recorded. Scripts can also be saved to disk and loaded later to make new animations. The script language itself is simple and contains only a few core commands to remember.

Scripts are checked automatically before you execute them or when they load to make sure the syntax is correct. Any errors will be reported at the bottom of the dialog box and the script won't run. The "Animate" button will execute the animation. You can watch the results of the animation in the graphics window if you move the animation dialog out of the way.

To actually make movies from the GIF or TIFF images that are generated, an external program such as iMovie on Mac or Ulead GIF Animator 5 on windows is required. Creating an animation can be a little tricky. A slideshow is much easier to make, and in some cases may be the better choice.

Creating an animation with Ulead:

1. The Files you create with Vis3D must be .GIF files for Ulead to work.
2. Open the Ulead GIF Animator program. Ulead can be obtained from the current CS co-op student, and should be on both general-use windows computers in 110.
3. Click 'File' then 'Add Image'. A dialog will appear asking you to select the images you wish to turn into an animation.
4. Select all the files you want to use.
5. There are two radio buttons on the bottom of this dialog box. Select the second one that says 'Insert as new frame(s)' then click open.
6. The first frame will appear blank. Select it, right click it and click 'Delete Frame'.
7. The order of the frames may need to be changed. To move a frame forward or backwards right click it, move your mouse to 'change frame order', and click 'move frame forward' or 'move frame backwards'.
8. The time between the frames may need to be changed. To change the time between frames select all the frames of the animation, right click them, and click 'Frame

Properties...' The time between frames is measured in x/100 seconds where x is the value you give. To set the delay to 1 second set x = 100.

9. a) It is now time to create the animation. Click 'File', 'save as', and then 'video file'. Select where you would like to save it, give it a name, and then click save. The default type is .avi, but .mpg is also an option.
   b) Instead of a video file a GIF animation can be created. To create a GIF animation click 'File', 'save as', and then 'GIF file'. Then pick a location and a name.

Creating an animation with iMovie:

1. The files you create with Vis3D must be .TIFF files for iMovie to work.
2. Open iMovie. IMovie should be on both general-use Macs in 110, and it is on most Macs by default.
3. Create a new project by going to 'File' and then 'New Project'.
4. Select and drag all the tiff files you wish to use into the project area.
5. By default iMovie applies the Kens Burns effect to all images added to it. To remove the Kens Burns effect hold ctrl and click anywhere in the project window then click on 'project properties.' At the top of the 'project properties' window there are two tabs, click 'Timing'. Change 'Initial photo placement' from 'Kens Burns' to 'Fit in frame'.
6. Next you need to change the duration of each image. The default is 4 seconds, and is way too long for normal purposes. Hit the 'i' key. This will bring up the clip adjustment window. Check the 'applies to all stills' box and change the duration of each image to what you want.
7. To save your video click on the 'share' tab at the very top of the screen then click 'export movie'. Select where you would like to save it and give it a name.

Control Commands

These commands can be used in the 3D animator, and they generally control how the movie is recorded and saved. In the reference below, the syntax [A | B] means that you must add either A or B after the command (though not both).

FOLDER [folderName]

Tells the animator where to save frames of the animation. Note the option to specify the folder name in the RECORD command instead. FOLDER must be specified before RECORD ON is used. The folder name must be a full path starting with the hard disk name, such as Mac

HD:John:Animations. Images are saved, by default, as TIFF files with the name “frameXXX.TIF” where XXX is the frame number.

SAVETYPE [TIFF|TIF|GIF]

Changes the save type to either TIFF or GIF. TIFF and TIF are the same thing.

RECORD [ON | OFF | folderName]

Tells the animator whether to save each new frame to an image file. Recording is off by default, meaning that animation commands are executed but the resulting image will not be written to a file. This lets scripts be tested before recording them. Once recording is turned on, every new image produced by the animator will be saved until recording is turned off.

The new RECORD folderName command is a shortcut; you can put:
RECORD folderName instead of:
FOLDER folderName
RECORD ON

RESET

Resets all parameters to default values.

RESOLUTION [res]

Specifies the resolution in which to save the frames. The default is the size of the Vis3D graphics windows, which is 512x512. Using this command will resize all images to res x res before saving them. This is useful to save disk space.

UPDATE

Updates the screen and saves the current frame if recording is on.

3D Animation Commands

ROTATE [X | Y | Z] [BY | TO] [theta] STEP [stepNumber]

Performs a rotation about the desired axis (X, Y or Z). If the BY option is set, the specified angle theta will be added to the current X orientation. If TO is used, the object is rotated until its angle with respect to the selected axis is theta. Use negative angles to rotate counterclockwise.

THRES [UP | DOWN | TO] [value] STEP [stepNumber]

Affects the intensity threshold value of the 3D image. Any pixels with intensities above the threshold are displayed; pixels with intensities below the threshold are not displayed. Using UP adds the specified value to the threshold, down subtracts the specified value, and TO raises or lowers the threshold until it reaches the desired level.

ZOOM [IN | OUT | TO] [zoom] STEP [stepNumber]

Changes the zoom factor, which is 1.0 by default. High factors mean higher magnification of a 3D object, so using ZOOM IN will increase the zoom factor by the specified

amount, and ZOOM OUT decreases it. ZOOM TO moves the zoom factor up or down until it reaches the specified value.

CHANGE_IMAGE [UP|DOWN|TO][Value] STEP [stepNumber]

Changes the currently viewed image. This is useful when viewing the internal flow of something over time.

About the STEP Option

This option is added to some of the animation commands to tell the animator how often to create a new image. For example, when doing a 90 degree rotation, setting STEP 5 will create a new image every 5 degrees, for a total of 18 images. Larger step values will result in smaller but jerkier animations. If STEP is not given, the animator goes directly to the desired position, which is useful for properly orienting the object prior to beginning animation.

Sample Animation Scripts

```
\ Sample 3D Animation script
\ Rotates a thresholded object 360 degrees around Z
\ Rotates X to 90, zooms to 1.0, finishes rotating X to 180
\ All images saved in 256x256 resolution
RESET
THRES TO 80
FOLDER Mac HD:John:Animations
RESOLUTION 256
SAVETYPE TIFF
RECORD ON
ROTATE Z BY 360 STEP 10
ROTATE X TO 90 STEP 10
ZOOM IN 0.3
ROTATE X BY 90 STEP 10
RECORD OFF
```

Miscellaneous Notes

- You can only put one command per line, though not every line must have a command.
- The backslash "\" denotes comments; all characters up to the end of the line are ignored.
- Comments can go on lines by themselves, or on the same line as a valid command, EXCEPT the FOLDER or RECORD commands, because a backslash might be the directory separating character on Windows.
- Parameters and options should be separated from the command itself by a single space.
- New animations will overwrite any that already exist in the target folder.